



AN EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES FOR REPLACEMENT OF RIVER SAND WITH SEA SAND AND ROBO-SAND IN CONCRETE

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ABSTRACT

Now a day's urbanization requires lot of ingredients in infrastructure development. Smart cities are always be safe and economical either in construction or living. In view of urbanization concrete is used for all type of constructions. Concrete is having cement, fine aggregate, course aggregate. Sand plays vital role in concrete in all type of constructions. In this study gives the comparative experimental results in compressive and tensile strengths of concrete for M20 grade under curing periods about 7 days, 14days and 28 days replaced fine aggregate with sea sand and robo-sand. The objective of this paper is to give detailed study whether robo sand and sea sand are advisable to use or not. The removal of salt and impurities from sea sand and river sand is mandatory. Using different proportion of sea sand and robo-sand in the place of river sand has been taken for tests.

Key words: compressive strength, split tensile strength, river sand, robo sand (manufactured sand) and sea sand (coastal sand).

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1. INTRODUCTION

Concrete is good building material for all strengthen aspects. We are using river sand as main ingredient of concrete in infrastructure development of towns and cities. Construction of any building component requires good quantity of sand. This river sand is non-renewable. Now-a-days good sand is not readily available, it is transported from a long distance. those resources are also exhausting very rapidly. so, it is a need of the time to find some substitute to natural river sand. At the same time, Governments of many developing countries ready to increase their infrastructure and transportation facilities for their fast-growing economy. India has been proposed for smart cities, so it brings us to study the alternate sand where the river sand is not available much. Due to various environmental issues Government, has banned the dragging of sand from rivers. Which causes scarcity in construction field? So, alternate material has to be produced. Sea sand and robo sand are the alternate material for exhausting river sand. Sea sand is very cheap in cost and easily available in coastal area but it contains alkali matter and impurities which are not good in concreting. This sea sand can get washed and used for many constructions. Robo sand is the one of the alternate material for river sand. This robo sand manufactured in industries by using crushers. These crushers bring the course aggregate to fine powder form having different proportions. The specific gravity of river sand is tested noted as 3.12 which is replaced with sea sand of specific gravity 2.89 and robo-sand of specific gravity of 3.36.

1.1. General Requirements of Manufactured Sand and Sea Sand

- All the sand particles should have higher crushing strength.
- The surface texture of the particles should be smooth.
- The edges of the particles should be grounded.
- The ratio of fines below 600 microns in sand should not be less than 30%.
- There should not be any organic impurities
- Silt in sand should not be more than 2%, for crushed sand.
- In manufactured sand the permissible limit of fines below 75 microns shall not exceed 15%.

2. MATERIAL USED

The following materials are used for this experimental study.

2.1. Cement

Cement of 53 grade cement is used confirming to various specifications as per IS: 12269-1987. Laboratory test results as follows, such as Specific gravity of cement 3.26 Standard Consistency of cement 34% Initial Setting Time of cement 115 min. Final Setting Time of Cement 310 min. Fineness modulus cement 6%.

2.2. Sand

2.2.1. Sea Sand

Usually, sea sand not preferred for any construction without washing and removed the salt and impurities. these properties are studied together with the other soil characteristics. The texture of sea sand may vary in a wide range from river sandy deposits. The grain size distribution of size fractions along the profiles of coastal soils is very uneven and rather random. The specific gravity of sandy soil is nearly 2.89. The bulk density of coastal soils

generally decreases from sandy to clayey soils, from mineral to organic soils. Simultaneously, increase in the water holding capacity is observed. The Physical and Chemical properties of sea sand are determined using granular size, pH test, chloride test.

2.2.2. River Sand

River sand is natural material used in construction of buildings and other structures. The specific gravity and other properties may have varied with sea sand and manufactured sand. River sand has varying proportions in grades classification. Specific gravity of river sand is 3.12. bulk density of sand is more than the other type of sands.

2.2.3. Robo Sand

Manufactured sand is called as robo sand. Where the scarcity of sand and quality constructions, it is better to use this robo sand. The specific weight of manufactured sand is 3.36.

2.3 Course Aggregate

Nominal size of 20 mm and 10mm is taken for concrete production. 10mm aggregate has specific weight of 3.53. And 20mm aggregate of specific weight is 3.56.

3. METHODOLOGY

3.1. Sampling

Fine aggregate comprises of three grades (i.e. River sand, Sea sand and Robo sand). River sand is collected from bank of Nagavali which is situated in Srikakulam district Andhra pradesh. This sample having some impurities which are sieved and cleaned to ready for concreting. Manufactured sand is brought from sridevi ready mix plant in Srikakulam. Sea sand near bhavanapadu fishing harbor which is used for most of the near-by constructions. This sample of sand contains salts more than permissible limit. So, this sample is washed and cleaned and dried.

Table 1 Sieve Analysis

Typical Sieve analysis:						
IS Sieve	% of passing (River Sand)	% of passing (Manufactured Sand)	% of sea sand passing	Cumulative Percentage re-trained, by mass (%)		
				(River Sand)	(Manufactured Sand)	sea sand
4.75mm	100	100	100	0	0	0
2.36mm	99.7	100	100	0.3	0	0
1.18mm	89	85.2	85	11	14.8	15
600micron	60.9	39.8	55.5	40.1	60.2	44.5
300micron	17.7	25.5	12.2	80.23	74.5	87.8
150micron	3.1	9.9	9.3	96.9	90.1	90.7
75micron	3	2.2	3	97	97.8	97
Total				325.53	337.4	335

Fineness modulus of river sand is $325.53/100=3.25$

Fineness modulus of manufactured sand is $337.4/100=3.37$

Fineness modulus of sea sand is $335/100=3.35$

3.2. Batching

3.2.1. Concrete Cube

Concrete grade = M20

Concrete mix design = 1: 1.5: 3

Cube size (volume) = $0.15 \times 0.15 \times 0.15 = 0.00375 \text{ m}^3$

Concrete density = 2400 kg/m^3

One cube weight = (density \times volume) factor = $(2400 \times 0.00375) \times 1.3 = 10.53 \text{ kg}$

One cube Cement content = $(10.53 \times 1) / 5.5 = 1.914 \text{ kg}$

One cube fine aggregate = $(10.53 \times 1.5) / 5.5 = 2.871 \text{ kg}$

One cube coarse aggregate = $(10.53 \times 3) / 5.5 = 5.743$

3.2.1.1. Water Cement Ratio

Water/cement = 0.45

Water content = cement \times 0.45 = $1.914 \times 0.45 = 861 \text{ ml}$.

3.2.2. Concrete Cylinders

Concrete grade = M20

Concrete mix design = 1:1.5:3

Diameter of cylinder = 15 cm

Height of cylinder = 30 cm

Area of cylinder = $\frac{\pi}{4} d^2 = \frac{\pi}{4} 0.15^2 = 0.0176 \text{ m}^2$

Cylinder (volume) = area \times height = $0.0176 \times 0.3 = 0.0053 \text{ m}^3$

Concrete density = 2400 kg/m^3

One cylinder weigh = (density \times volume) factor = $(2400 \times 0.0053) \times 1.3 = 16.536 \text{ kg}$

One cylinder Cement content = $(16.536 \times 1) / 5.5 = 3 \text{ kg}$

One cylinder fine aggregate = $(16.536 \times 1.5) / 5.5 = 4.509 \text{ kg}$

One cylinder coarse aggregate = $(16.536 \times 3) / 5.5 = 9.019 \text{ kg}$

3.2.2.1. Water Cement Ratio

Water/cement = 0.45

Water content = cement \times 0.45 = $3 \times 0.45 = 1350 \text{ ml}$

Table No: 4.18 Materials Used for One Concrete Cylinder.

3.3. Concreting

A building material made from a mixture of broken stone or gravel, sand, cement, and water, which can be spread or poured into moulds and forms a stone-like mass on hardening.

4. EXPERIMENTAL DATA

Experimental tests conducted on fresh concrete and hardened concrete as follows

4.1. Workability

The concrete should have good workability. It is defined as the ease with which it can be mixed transported and placed in position in homogeneous state. It depends upon the quantity of water, grading of aggregate and percentage of fine materials in the mix.

4.1.1. Workability Tests on Concrete

4.1.1.1. Slump Test

Slump test is used to determine the workability of fresh concrete. Slump test as per IS: 1199 – 1959 is followed. The apparatus used for doing slump test are Slump cone and tamping rod.

4.1.1.2. Vee-Bee Consisto-Meter Test

To determine the workability of fresh concrete by using a Vee-Bee consisto-meter as per IS: 1199 – 1959. The apparatus used is Vee-Bee consist-meter.

4.1.1.3. Compaction Factor

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS:1199–1959.

Table 2 Workability of concrete

Type of fine aggregate replaced	Workability of concrete		
	Slump test(mm)	Vee-Bee ConsistoMeter Test (sec)	Compaction Factor (%)
River sand	145	11.5	86.35
Robo sand	120	12	89.32
Sea sand	93	7	78.68

4.2. Compression Test

Compression strength of concrete with and without basalt was conducted. The compression test was conducted as per IS 516. The test specimen is casted and after 24 hours placed and cured for 7 days, 14 days and 28 days. The test specimen is removed from water and placed in compressive testing machine. Load applied gradually, noted failure data. The test was carried same procedure for all concrete specimen. Compressive strength is calculate using the following formula

$$\text{Compressive strength (N/mm}^2\text{)} = Wf / Ap$$

Where Wf = Maximum applied load just before load, (N)

Ap = Plan area of cube mould, (mm²).

4.2.1. Target Mean Strength for Mix Proportioning

$$F_t = F_{ck} + 1.65 s$$

Where F_t = Target average compressive strength at 28 days,

F_{ck} = Characteristic compressive strength at 28 days,

s = Standard deviation From Table 1 standard deviation, $s = 4 \text{ N/mm}^2$ (IS 456 2000)

Therefore, target strength = $20 + 1.65 \times 4 = 26.6 \text{ N/mm}^2$.

Table 3 Compressive strength of river sand concrete, robo sand concrete and sea sand concrete at 7 days, 14 days and 28 days.

Sl.no	M20 grade concrete (Replaced fine aggregate)					
	River sand		Manufactured sand		Sea sand	
	Cube compressive strength (N/mm ²)	Average compressive strength (N/mm ²)	Cube compressive strength (N/mm ²)		Cube compressive strength (N/mm ²)	Average compressive strength in (N/mm ²)
7 days	13.59	14.31	12.39	12.8	7	8.55
	14		12.56		8.79	
	15.35		13.45		9.87	
14 days	19.8	21.03	19.65	20.85	16.32	17.14
	20.5		20.36		17	
	22.80		22.56		18.12	
28 days	27.32	27.9	28.34	28.8	20.13	22.93
	28.12		28.69		22.36	
	28.26		29.38		26.32	

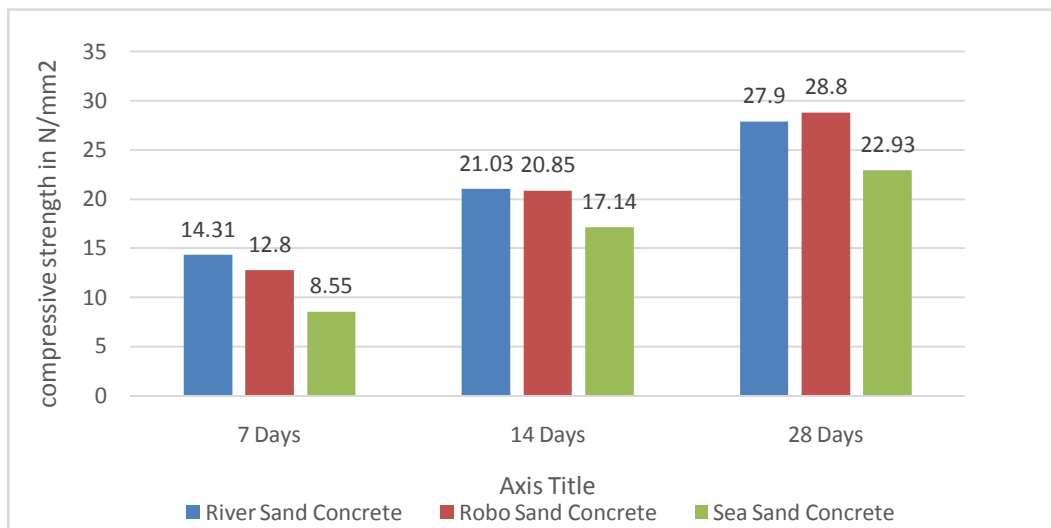


Figure 1 Variation of compressive strength of concrete replaced river sand with robo sand and sea sand individually.

4.3. Spilt Tensile Strength Test

This test was conducted as per IS 5816:1999. 300 mm length and 150 mm diameter of cylindrical mould is used to find the tensile strength of concrete. Cylindrical test specimen is

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casted and cured for 7 days, 14 days and 28 days. Cylinder is placed its longitudinal axis normal to the direction of load. Noted the failure point, the tensile strength of concrete is calculating by using following formula.

As per IS: 456 split tensile strength of concrete. $= 0.7F_{ck}$.

The splitting tensile strength is calculated using the formula $= T_{sp} = 2P/\pi DL$

Where P = applied load

D = diameter of the specimen

L = length of the specimen

Therefore P $= T_{sp} \times \pi DL/2$

Expected load $= P \times F.S$

Split Tensile Strength (T) $= 2P/ \pi DL$

Table 4 Compressive strength of river sand concrete, robo sand concrete and sea sand concrete at 7 days, 14 days and 28 days.

SI.no	M20 grade concrete (Replaced fine aggregate)					
	River sand		Manufactured sand		Sea sand	
	Split tensile strength (N/mm ²)	Average split tensile strength (N/mm ²)	Split tensile strength (N/mm ²)	Average split tensile strength (N/mm ²)	Split tensile strength (N/mm ²)	Average split tensile strength (N/mm ²)
7 days	1.368	1.763	1.12	1.192	0.965	1.461
	1.963		1.236		1.852	
	1.960		1.220		1.568	
14 days	1.988	2.161	1.389	1.468	1.698	2.013
	2.262		1.547		1.986	
	2.235		1.468		2.356	
28 days	2.870	2.849	1.568	1.746	2.689	2.823
	2.786		1.689		2.856	
	2.893		1.982		2.925	

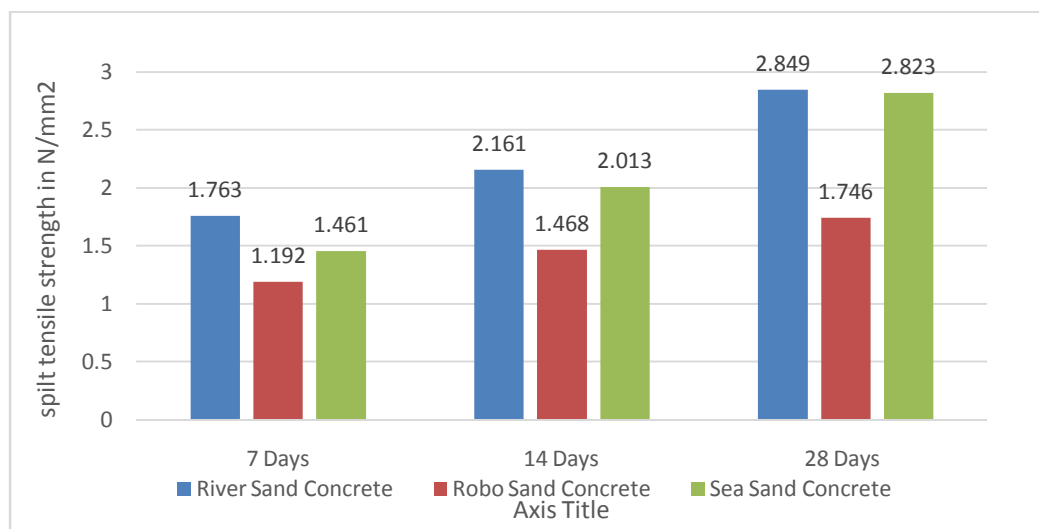


Figure 2 Variation of compressive strength of concrete replaced river sand with robo sand and sea sand individually.

5. RELUTS AND DISSUCIONS

From graph no.1 the compressive strength of robo concrete is less than with river concrete about 10.5% and 0.8% with respective 7 days and 14 days respectively but robo sand concrete have 5.4 % of strength increment in 28 days than the river sand.

This variation of strength is due to uniformly grades sieves in robo sand than river sand.

From graph no.1 the compressive strength of sea sand concrete is decreased with river concrete about 40%, 20% and 17.8 % with respective 7 days, 14 days, and 28 days respectively.

From graph no.2 the split tensile strength of robo sand concrete is lower than the river concrete about 32.3%, 32.06% and 38.71% with respective 7 days, 14 days, and 28 days respectively.

From graph no.2 the split tensile strength of sea sand concrete has constant variation with river concrete about 17.1%, 6.84% and 0.9% with respective 7 days, 14 days, and 28 days respectively.

From the above observations sea sand, has not reached to its target strength 26.6 N/mm². Sea sand is not desire to use in place of river sand where as robo sand has got good compressive strength than the river sand so robo sand can use for all the constructions.

6. CONCLUSION

Infrastructure development is major objective of smart cities in developing countries. To avoid the scarcity of fine aggregate for future development in construction field. It is suggested to choose the alternate material as fine aggregate to make economic and safe construction. Robo sand has reached the target strength in all ages so Robo sand can manufacture on site for huge construction projects will reduce the cost of river sand transportation and makes the structure safe. One more choice is use sea sand as fine aggregate in coastal area for low level constructions i.e. for road pavements, etc. Due to low compressive strength in concrete but sea sand should be washed and clean all impurities then it is ready to use. From the above study robo sand suggested to use for all important strictures where river sand is not available.

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